THE CORNELL READING COURSE FOR THE FARM

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LESSON 143 FARM CROPS SERIES MARCH, 1919

POTATO GROWING IN NEW YORK

E. V. HARDENBURG

HARVESTING 300 BUSHELS OF POTATOES TO THE ACRE IN FRANKLIN COUNTY
Removing the tops from the potatoes as they are dug, to facilitate picking

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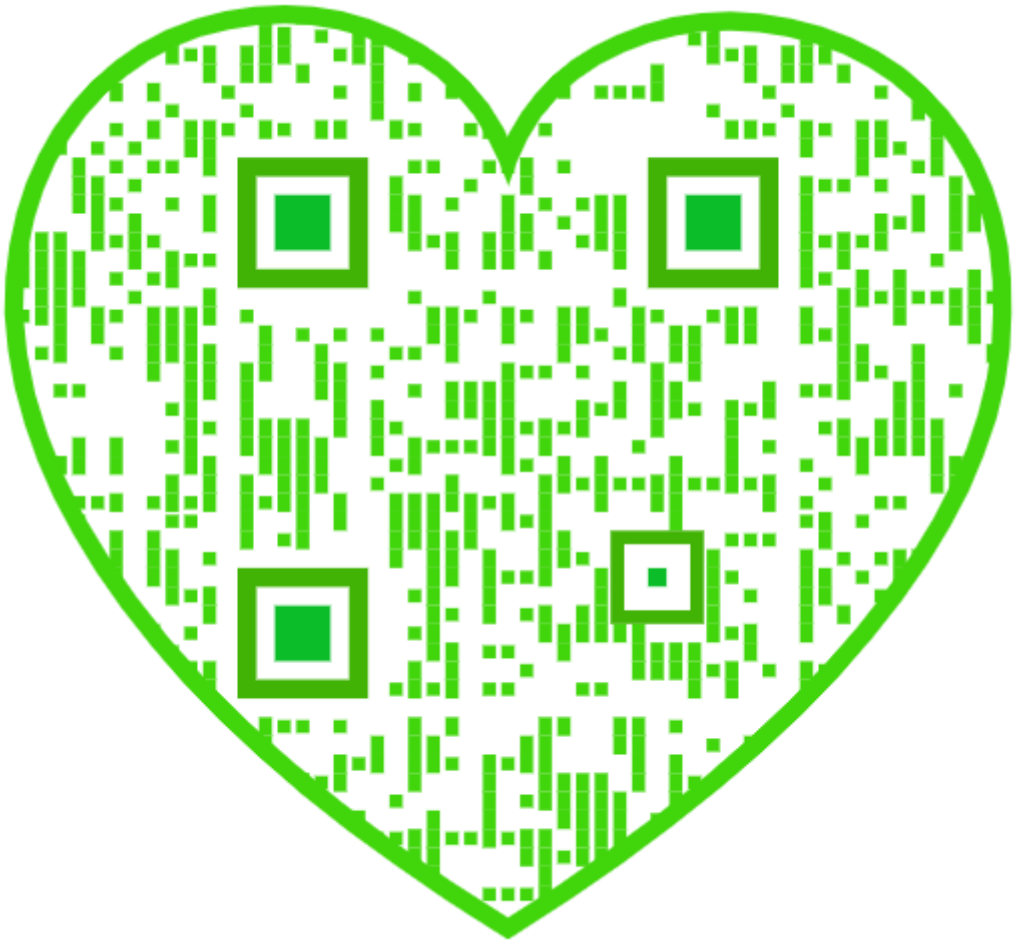

THE CORNELL READING COURSE FOR THE FARM

SUPERVISOR
ROYAL GILKEY

EDITORS FOR THE COLLEGE
BRISTOW ADAMS
RUTH VAN DEMAN

"No other human occupation opens so wide a field for the profitable and agreeable combination of labor with cultivated thought as agriculture."—ABRAHAM LINCOLN.

The increased area for world food production in 1919 indicates that New York farmers should return to sound permanent systems of farming. The combination of cultivated thought with labor not only is agreeable but results in efficiency in farming, which makes profits possible when price levels are becoming lower. The State College of Agriculture offers lessons for home study free to residents of New York State. The reader may obtain consecutive instruction on the subjects in which he is interested, and also the new lessons as issued. The attached discussion paper gives further information.

The reading-course lessons for the farm are elementary and brief, and are intended to arouse a desire for additional knowledge. Advanced reading courses in farm crops, fruit growing, and vegetable gardening, provide more complete instruction in accordance with modern correspondence methods. Reports on the reading and practical exercises are corrected, graded, and returned to the reader with suggestions from specialists. The only expense in each advanced reading course is the cost of a textbook and practice material.

The reading-course lessons make useful material for educational programs in granges and other local organizations. In a number of communities groups have organized for the discussion and study of common problems, and have adopted the name *Cornell Study Club*. This may be done in connection with an existing organization or independently. Assistance is given in organizing and conducting Cornell study clubs.

Correspondence is a medium for the exchange of helpful information. Letters will receive careful attention.

POTATO GROWING IN NEW YORK

E. V. HARDENBURG

The potato as food for human consumption has had a steadily increasing production ever since it was introduced from its native home in the highlands of Peru. Tho more people depend on rice as a staple article in the daily ration, potatoes rank first as a world food crop on the basis of actual pounds produced. Probably no other crop furnishes so much actual volume of starchy food for the labor involved in production. The potato owes its great value to the production of enlarged underground stems, known in this case as tubers.

BOTANICAL RELATIONSHIP

Since the potato tuber is really a stem and not a part of the plant root, it may be compared in every way to an aerial stem similar to that of the apple or the peach. Its eye bud corresponds to the bud on an apple twig, while the brow, or ridge, of the eye corresponds to the leaf scar of the twig. In internal structure, a similar comparison may be drawn. Both longitudinal and cross sections of a potato tuber and of a normal aerial stem are shown in figure 86. In cross section a potato consists roughly of two parts, the cortical layer, or outer portion, and the medullary, or inner, area. By close observation on holding a cross section to the light, it may be noted that the medullary, or inner, portion is differentiated into an inner less dense portion and an outer portion richer in starch. This innermost part corresponds to the pith, while the outer medullary part corresponds to the woody portion of an aerial stem. The cortical layer surrounding the medullary part corresponds roughly to the bark of a stem. This cortical layer contains a high concentration of the food elements of

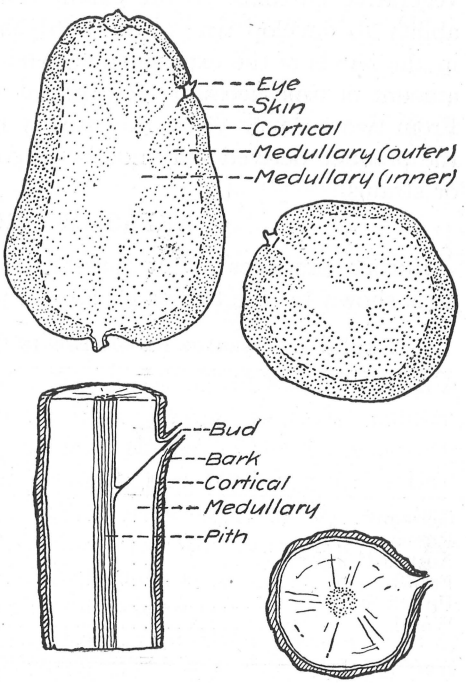

FIG. 86. LONGITUDINAL AND CROSS SECTIONS OF A POTATO TUBER AND OF A NORMAL AERIAL STEM

the potato, including protein, starch, ash, and fiber. This is why potatoes should be pared thinly to avoid needless waste of the most valuable portion.

The potato is the most important of a large group of crop plants belonging to the botanical family known as Solanaceæ. Close relatives, the flowers and in many cases the foliage of which resemble those of the potato, are tomato, eggplant, henbane, belladonna, and nightshade. Most of these plants are propagated by means of true seed, the result of cross-pollination. The seed is borne in pulpy fruits of various shapes and sizes, in many cases containing from one hundred to three hundred kidney-shaped seeds. This in fact is the nature of the true seed of the potato, the fruit of which is popularly known as potato seed balls. Seed balls are not found in abundance, as was once the case, and it is now the exception rather than the rule to find them in any field of growing potatoes. The scarcity is probably due to such factors as failure of the pollen to ripen, sterility of the pollen grains, and propagation of the plant by tubers, or vegetative cuttings, to the extent that it has in large measure lost its ability to develop true seed. Seed balls are of little or no value except in the hands of the experimenter, who alone can afford to spend the large amount of time necessary to produce marketable-sized tubers from them. From two to four years are usually required to do this, and even then the product derived may not be of so much value as existing varieties or strains.

AREAS OF PRODUCTION

Europe produces about four-fifths of the potato crop of the world, as is shown by the figures on annual production in table 1:

TABLE 1. AVERAGE PRODUCTION IN BUSHELS BY COUNTRIES (1909–1913)

Country	Production in bushels	Average yield per acre (bushels)
Germany	1,681,959,000	201
Russia	1,252,364,000	106
Austria-Hungary	662,202,000	131
France	484,960,000	130
United States	356,627,000	96
World	5,487,326,000	.....

In spite of this enormous production in so few of the countries of the world, these countries consume nearly all of the crop at home. This is especially true of the United States. Whereas this country exports annually only 1,044,000 bushels, the imports amount to 2,103,000 bushels, leaving a net consumption of 1,059,000 bushels more than are produced.

These figures are the average for the past twenty years. The foreign trade of the United States in potatoes is therefore relatively small.

In the United States the potato crop ranks sixth in acreage with corn, wheat, oats, cotton, and barley, fourth in production with corn, oats, and wheat, and fifth in value with corn, cotton, wheat, and oats, in the order named. Production is largely centered in the States bordering the Great Lakes, probably due to the moderately cool climate of those States. Tho Maine does not border the Great Lakes, her rank is fourth in production, due to the cool summers of that latitude and to the extra heavy yields obtained in the single county of Aroostook. New York has ranked first as a potato State for many years, tho recently Michigan, Wisconsin, and Minnesota have competed closely for first rank in production. The acreage, the production in bushels, and the average yield per acre for the six leading States, as based on the crops of 1910–1914 inclusive, are shown in table 2:

TABLE 2. ACREAGE, PRODUCTION, AND AVERAGE YIELD PER ACRE BY STATES

State	Acreage	Production in bushels	Average yield per acre (bushels)
New York	380,000	33,442,000	88
Michigan	345,800	36,118,000	104
Wisconsin	286,000	32,390,000	113
Pennsylvania	277,600	24,725,000	89
Minnesota	236,000	26,009,000	110
Maine	124,000	26,861,000	216
United States	3,659,400	357,928,200	98

Tho potatoes are grown more or less in all sections of New York State, production is distributed roughly in four principal sections, namely: (1) western New York, comprising all that portion of the State directly south of the western end of Lake Ontario and bordering Lake Erie; (2) Franklin and Clinton Counties; (3) the upper Hudson River valley, mainly Washington and Rensselaer Counties; (4) Long Island. The twenty-one counties of the State that produce annually over a million bushels are shown in figure 87, on the following page.

According to the United States Census of 1910, more bushels of potatoes are produced annually in New York State than of any other single crop, and, with the possible exception of apples, potatoes rank first in total value.

CLIMATE AND SOIL

Potatoes require a cool, moist summer climate. Regions in which the summer temperature sometimes rises to 85° F. or above for very many

successive days are not adapted to maximum yields. The high yields obtained under the equable, cool climates of Scotland and northern Germany are largely due to this factor.

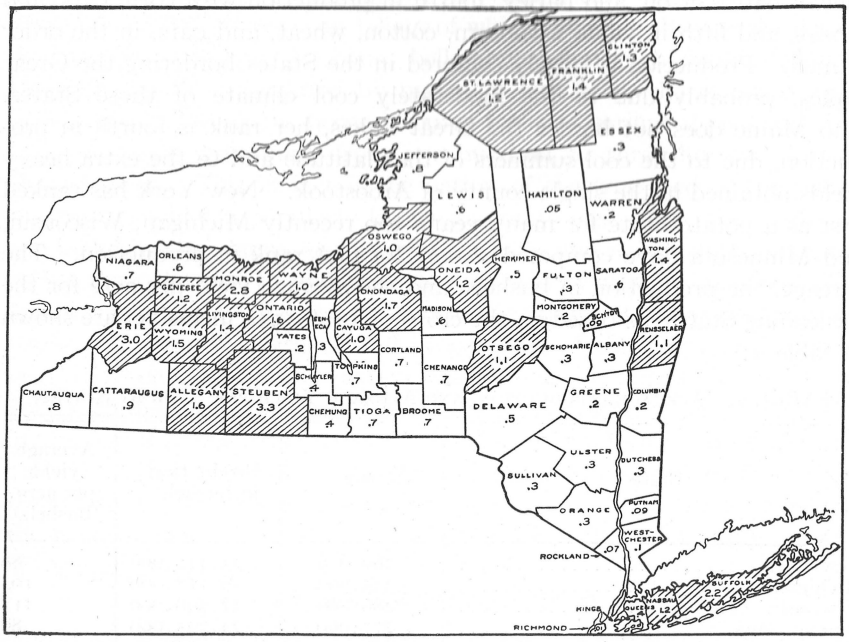

FIG. 87. WHERE THE POTATO CROP OF NEW YORK IS GROWN
The figures are taken from the 1910 Census of the United States and represent millions of bushels. The shaded counties produce at least a million bushels annually

The relation between average growing-season temperature for June, July, and August, and yield per acre in New York, Maine, and Scotland, is shown in table 3. This indicates the advantage of the cooler climates of Maine and Scotland over that of New York.

TABLE 3. RELATION OF MEAN TEMPERATURE FOR JUNE, JULY, AND AUGUST, TO YIELD IN 1909

Region	June (degrees Fahrenheit)	July (degrees Fahrenheit)	August (degrees Fahrenheit)	Yield per acre (bushels)
New York	65.0	70.0	67.0	123
Maine	61.9	66.9	65.0	210
Scotland	55.0	58.0	58.0	350

Rainfall and length of growing season are seldom limiting factors to production in this State. The principal potato sections are located in

areas subject to both minimum and maximum rainfall during the growing season and in which the growing season varies from one hundred and fifty to two hundred days (table 4):

TABLE 4. LENGTH OF GROWING SEASON AND AMOUNT OF RAINFALL DURING GROWING SEASON IN PRINCIPAL POTATO SECTIONS OF NEW YORK

Region	Average date of last frost in spring	Average date of first frost in fall	Number of days in growing season	Rainfall during growing season (inches)
Steuben County	May 10	Oct. 5	150	16–18
Monroe County	May 1	Oct. 15	165	14–16
Washington County	May 5–10	Oct. 1	150	16–18
Franklin and Clinton Counties	May 10	Oct. 1–10	150	14–18
Suffolk County	April 25	Oct. 1–25	200	16–20

Soil type is probably of less importance than climate, since fair yields are produced on all but the very heaviest types of soil in many parts of the United States. The ideal potato soil is a light, workable loam of medium texture, relatively rich in humus. Light soils are better than heavy soils because they are more conducive to disease control, ease in planting and harvesting, well-shaped and uniform tubers, good quality, and early maturity.

ROTATIONS AND FERTILIZERS

The large variety of crops produced makes it difficult to define the commonest place that the potato crop occupies in the rotation. Where corn is grown, potatoes usually follow it, the corn being given the advantages of a turned sod. This allows the corn as a coarse feeder to make use of the top-dressing of stable manure applied to timothy sod just before plowing, and allows the potato crop to make use of the residual manure in a more finely divided form. Also a better tilth of seedbed is obtained for potatoes in this way. In the potato sections of northern, southern, and western New York, where corn is relatively less important than in the more specialized dairy sections, potatoes generally follow hay. The longer rotations, in which the timothy sod remains for three years or longer, in many cases result in a sod residue so impoverished as to be of small value as fertilizer for the potato crop. This fact is illustrated by the lower average yields obtained in Steuben County in the longer rotations, as shown in table 5.

It is evident that better yields would result if a better sod residue were turned under for potatoes. This could be accomplished either by plowing

TABLE 5. RELATION OF ROTATION TO YIELD ON 228 FARMS IN STEUBEN COUNTY IN 1912

Rotation	Manure or fertilizer on part of acreage		
	Number of farms	Average yield per acre in bushels	Average number of bushels of seed used per acre
Potatoes, grain, hay	13	177.0	10.9
Potatoes, grain, hay, hay	117	134.9	10.3
Potatoes, grain, hay, hay, hay	62	122.7	10.0
Potatoes, grain, grain, hay, hay	25	150.1	9.2
Potatoes, grain, grain, hay, hay, hay	11	143.0	8.8

under newer sod or by applying the stable manure as a top-dressing on the second- or the third-year stand of hay instead of just before plowing for potatoes.

In case lime is needed to correct soil acidity, it may be applied directly after the potato crop, and the organism causing potato scab, ordinarily favored by the resulting alkaline soil, will not seriously affect the succeeding potato crop on account of the intervening crops in the rotation. Lime so applied will also benefit the clover seeding that usually accompanies oats or wheat following potatoes. In sections where the white grub has proved disastrous to the potato crop, this practice of growing a cultivated crop, such as corn, between sod and potatoes will tend to control this insect. The principle applies equally well to the control of wireworms. Fall plowing, exposing the larvae of both these beetles to the action of winter freezing and thawing, will also assist in their control.

Owing to the desirable form of organic nitrogen furnished in clover sod, an ideal three-years rotation consists of clover, potatoes, and oats or wheat. In order to counterbalance the heavy demands on soil fertility caused by the frequency of potatoes in so short a rotation, commercial fertilizers and lime if needed should be applied with the grain crop, and stable manure on the sod. This keeps the lime farthest from the potato crop and benefits the clover. In sections such as Long Island, where successive crops are grown on the same land, large amounts of fertilizer are necessary to maintain yields. Rye is often used as a fall-seeded green-manure crop to furnish humus. Heavy types of land to be devoted to potato growing are improved greatly by proper drainage and liming. The taproot system of buckwheat makes this crop of much value in breaking up new land where the subsoil is inclined to be hard.

Under normal conditions, complete fertilizers, analyzing relatively high in potash and phosphoric acid, are recommended, since the potato plant draws heaviest on these elements. The analysis used most commonly in New York before the war was 2–8–10. Sandy soils devoted to potato culture are usually lower in potash content than those of heavier type. For this reason, growers until recently have used larger amounts of potash in commercial fertilizers on Long Island than in other sections of New York. More than fifteen hundred pounds per acre of such fertilizer has not been considered profitable. Less potash is now being recommended and used than formerly. At times like the present, when the supply of German potash is cut off, commercial forms of potash cannot profitably be used. Practices that will make more available the potash already in the soil should be observed. These are liming, thoro tillage, and the addition of such organic manures as are available. Complete fertilizers for most of the heavier soils of New York probably should analyze higher in phosphoric acid than in potash. This, however, is a factor to be determined by test in the locality concerned. Nitrogen in fertilizer tends to increase foliage production and to prolong growth; phosphoric acid, in addition to increasing yield, hastens maturity; and potash increases yield and improves quality. On the average potato soil, one-half the nitrogen should be applied in some slowly available form, such as ammonium sulfate, the other half in a more quickly available form, such as nitrate of soda. The phosphoric acid is most commonly applied as acid phosphate. The two common sources of potash are sulfate and muriate, or chloride, of potash. Tho the muriate is usually cheaper and more commonly used than the sulfate either alone or in complete fertilizer, the chlorine contained in it is sometimes said to be somewhat detrimental to quality.

Wherever machine planters are used, the fertilizer is usually applied from a hopper just in front of the seed. In this way it becomes mixed with the soil, and there is little danger of burning the seed. Where no planter is used, it is either drilled, just before or just after planting, with a grain drill or a lime sower, or strung by hand in the open furrow ahead of planting. In the latter case care should be used to avoid direct contact of seed and fertilizer, in order to prevent injury to the seed.

SEED

It is common knowledge that potatoes tend to lose vitality, or "run out," under the influence of a hot summer climate, warm storage conditions, or excessively dry soils. This often necessitates a renewal of seed. Southern growers find it necessary to buy northern-grown seed every year on this account. Growers in New York need not renew seed so often,

tho an occasional renewal of vigor from seed grown in northern New York or Maine is sometimes desirable. Indications of degeneracy in a variety are the tendency of the tubers to become pointed at the ends, or spindle-shaped, failure to come up uniformly, decreasing yield, and failure to develop vigorous, dark green tops.

Most seed is not given sufficient care in storage. It should be stored under moderately dry, cool, well-ventilated conditions. A temperature of 40° to 45° F. is best in order to maintain the dormancy of the tubers. A storage too warm tends to hasten the ripening process and promotes early sprout development. These sprouts when removed weaken the vigor of the seed, and those that develop later are not so good. Too much moisture in storage encourages the development and spread of late blight and bacterial rots.

It is desirable to bring seed into subdued sunlight about two weeks before planting time in order to develop short, green, rugged sprouts. This practice, known as "sprouting," or "greening," facilitates a saving of time when an early crop is desired and the soil is yet too wet and cold for immediate planting. It also gives an opportunity to cull out diseased and dormant tubers. The sprouts should not be allowed to become more than a half inch long; otherwise they are likely to be knocked off in planting.

If the seed is affected with either scab or the rhizoctonia disease, it should be chemically treated before "sprouting" or cutting is done; otherwise injury may result to the sprouts. If both diseases are present, corrosive sublimate (mercuric bichloride) should be used, as this is effective in the control of both. If scab alone is present, formalin (40-per-cent formaldehyde) is sufficient. Formalin is not effective in the control of rhizoctonia disease.

Corrosive sublimate is used at a strength of 4 ounces to 30 gallons of water, and the uncut seed is immersed in this solution for one and one-half hours. This is a deadly poison and should not be left accessible to livestock or children. In contrast to formalin, it loses strength rapidly with use, and the same solution should not be used more than three times. Corrosive sublimate will corrode metal containers and rapidly lose its strength in them; therefore this solution should be used only in wooden or earthen vessels.

Formalin is used at a strength of 1 pint to 30 gallons of water, and the seed is immersed for two hours. In buying formalin, care should be used to get the standard 40-per-cent strength, since old formalin or that sold by unscrupulous druggists may be weaker and hence not effective.

Seed may be treated at any time during the dormant period, but the storage bags or barrels should be treated with formalin before the seed is replaced in them, in order to prevent further contamination. All treated

seed should be well dried before storing, in order to prevent heating. Seed tubers should not be cut more than two days previous to planting, since cut seed decreases in vitality due to bleeding and drying if left longer than this. Much of the seed used in this State is cut on either the day before or the day on which it is planted. On account of large acreages and much labor in cutting, many growers on Long Island who buy their seed from Maine or upper New York in large quantities find it advisable to cut seed a week or more ahead of planting. The drying and bleeding of seed in this case is lessened by dusting the cut surface with land plaster, or gypsum. Land plaster is adhesive and does not injure the cut seed. It is probably not profitable nor necessary to dust cut seed except in case it is to be stored for more than three or four days after cutting. Such seed

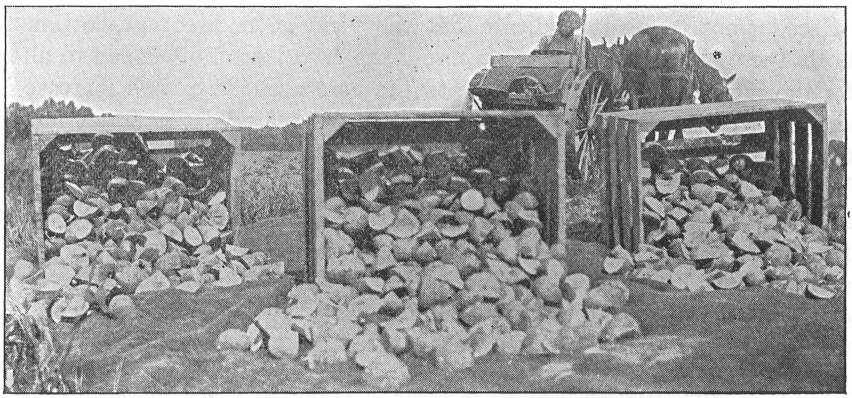

FIG. 88. DESIRABLE TYPES OF SEED PIECES

Compact seed pieces not smaller than a hen's egg and with a minimum of cut surface are most desirable

should be spread thinly to prevent heating during storage. Desirable types of seed pieces are shown in figure 88.

One vigorous eye on each seed piece is sufficient. In case seed is not especially vigorous, it is safer to leave two or more eyes in order to insure germination. Size of seed piece is much more important than number of eyes. Pieces weighing less than two ounces, or smaller than a hen's egg, are usually not desirable. Since the eyes at the bud, or "seed," end of the tuber are more vigorous than those at the stem end, it is never advisable to discard that end because of any likelihood of small potatoes forming as a result of such pieces. "Seed"-end pieces may result in more culls if planted with the entire bud cluster, but this can be prevented by cutting the tuber from end to end. The stem-end pieces may be made of equal value to those from the seed end by cutting them larger, in order to counterbalance their less vigorous eyes.

It is advisable to cut seed when it is of large type and relatively

expensive, and when labor is cheap. Cutting is an important labor item, since the cutting of twenty bushels is an average day's work. Machine cutters are quicker, but, since they do not permit of sufficient care in cutting, they are probably not practicable. Small potatoes should not be used for seed unless seed is very expensive and they are known to come from good-yielding hills. In using small seed selected from the storage bin, the chances more than favor its having come from degenerate hills.

In general, yield is directly proportional to the size of seed piece used. The investigations of most experiment stations show that yield is profitably increased up to and including half tubers, and that as a rule the yield from whole potatoes does not warrant the extra expense of seed.

A majority of the hundreds of experiments carried on at various stations in this country to determine the best number of eyes and the best size of seed piece to plant, indicate that the yield is in direct proportion to both these factors. However, these tests have generally failed to allow for the increased amount of seed, to the acre used with each increase in size of seed piece or number of eyes. The really determining factor, therefore, is amount of seed, and not number of eyes nor size of piece. Yield is directly proportional to the number of bushels planted to the acre up to 20 bushels. Most growers plant too little seed, the average for the State being about 12 bushels. An average of about 10 bushels is planted in Steuben County, while Long Island growers plant an average of 12.5 bushels. The relation of amount of seed to the acre to yield on 360 farms in Steuben County is shown in table 6:

TABLE 6. RELATION OF AMOUNT OF SEED PLANTED TO YIELD ON 360 FARMS IN STEUBEN COUNTY IN 1912

Number of farms	Amount of seed planted per acre (bushels)	Average yield per acre (bushels)
19	6– 8	117.8
138	8–10	123.1
126	10–12	138.3
57	12–14	147.7
15	14–16	176.3
5	16–18	224.8
360	10.1	136.4

PLANTING

The average date of planting for most sections of New York, outside of Long Island, is about June 1. The best time to plant, however, depends

on local conditions, such as fitness of the seedbed and average date of the last killing frost in the spring. Potato growers on Long Island plant as early as April 10 to April 25 on account of an early season and a light, sandy soil. They are therefore able to put their crop of early varieties on the New York markets before the crop from other sections of the State is ready.

Potato seed is likely to rot before germinating, on account of cold, wet soil, if planted too early. Usually the crop may be planted somewhat earlier on the lighter soils and at the lower elevations. The earliest date at which potatoes can be planted with safety in most sections of the State is indicated in table 4, which gives the average date of the last

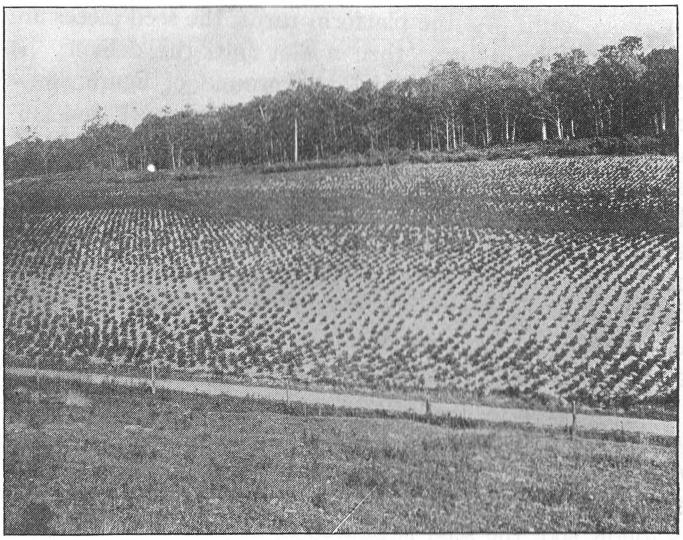

FIG. 89. CHECKROWED POTATO FIELD ON A HILL FARM IN STEUBEN COUNTY

killing frost in the spring. Usually planting should be so timed that the period of tuber formation will come during the cool part of the growing season. For much of the State, the crop may be planted as late as June 1 to 10 to best withstand midsummer heat and drought.

With the exception of some of the hill farms of southern New York, most of the crop of the State is planted in continuous drill rows rather than in checkrows. Experiments and actual farm practice show that the yield is considerably better where the former method is used. On the average, three bushels more seed to the acre is required for drill planting than for checkrow planting. Still the extra yield resulting makes this method much more profitable on most farms. The principal advantage of planting in checkrows is that it permits of cross-cultivation in the

control of weeds. In general it is advisable to plant in checkrows only when land is relatively cheap, labor is expensive, and weed control is likely to be an important factor. A checkrowed field of potatoes on a hillside farm in Steuben County is shown in figure 89.

Probably more than half of the acreage in New York State is planted with machines, which are of two types—the one-man, or picker, type, and the two-man, or platform, type. The one-man planter has a vertical rotary set of iron hooks, or pickers, which pick the seed pieces from the containing hopper and carry them down, one at a time, and drop them automatically thru the delivery hose. The platform type has a chain-driven carrier, which takes the seed pieces from the hopper to a horizontal platform. As the platform turns, the seed pieces are dropped automatically, one at a time, thru a slot into the delivery hose. The platform planter is shown in the background of figure 88. An extra man is required to sit behind the platform to see to it that single pieces are deposited uniformly. The picker planter usually costs about $60, while the platform type costs about $75. It is generally thought that the better stand resulting from the use of the platform type more than pays for the extra labor required and the higher initial cost of the planter.

A recent investigation by the College of Agriculture shows that it is economical to operate a machine planter, rather than to plant by hand, wherever the area of potatoes is at least five acres. Besides this, the advantages of machine planting over hand are more uniform distribution of seed and fertilizer, and quicker covering of the seed to prevent drying out in the open furrow. No extra labor is required for marking the rows where machine planters are used, since these machines mark and plant in one operation. In some sections where the acreages are small and potatoes follow sod, the seed is plowed in at the time of turning the sod, the land being rolled and harrowed immediately afterward. Tho there is some saving of labor in this method, it is usually advisable only on loamy soils in which moisture capillarity is readily readjusted.

The best depth at which to plant is that at which the most uniform supply of moisture prevails thruout the growing season. For most soils this is about four inches. Planting should be shallower in heavy soils and deeper in light soils. Potatoes planted too close to the surface are subject to sunburning and are usually of poorer quality than those planted deeper. The principal objections to deep planting are the difficulty in harvesting and the greater susceptibility to rot in heavy soils. Where ridging is practicable, the seed may be planted very shallow and the dirt gradually worked toward the row, covering both the seed and the weeds as the season advances. This is the system in common use in Maine where labor is relatively scarce except at harvest time.

CULTIVATION

Like most other cultivated crops, potatoes require clean cultivation, the frequency being determined largely by soil types, available moisture, and condition of seedbed. Thoro tillage is more important during early growth than later. An implement somewhat resembling a horse rake and known as a weeder (fig. 90) is commonly used on Long Island and to a limited extent in other sections of New York, to keep down newly germinated weeds. The weeder is used frequently without damage to the growing tops, until the plants have reached a height of from five to six inches. Where soil moisture is deficient and the soil of heavy type, cultivation (fig. 91) every week or ten days is advisable to maintain a

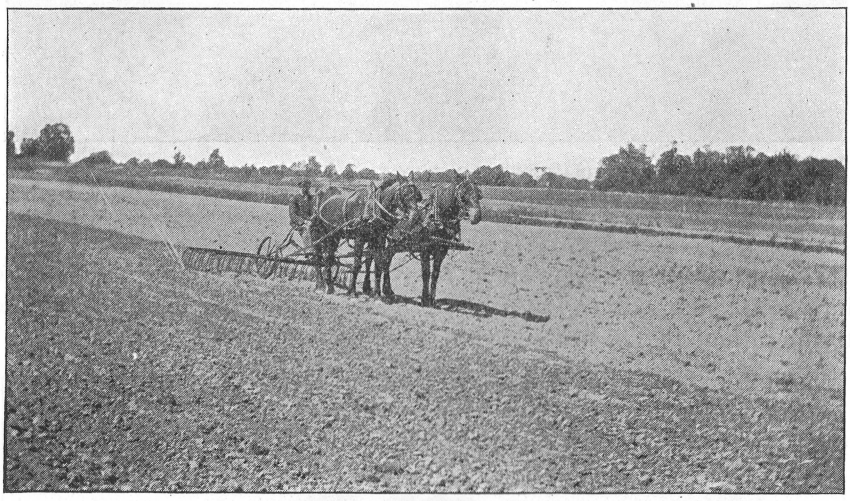

FIG. 90. A POTATO WEEDER

This is an efficient tillage implement both in preparing the land and in caring for the crop up to a growth of four to six inches of top

surface mulch for moisture conservation. Under moderate rainfall and on light soils, less frequent tillage is necessary.

There are two general systems of culture in practice, namely, level and ridge. The latter system is by far the more common in New York, tho Long Island growers use the nearest approach to level culture of any in the State. These growers ridge very slightly late in the growing season, for the purpose of protecting the tubers from infection by the fungus causing late blight. Ridge culture is adapted to most regions of relatively high rainfall and to the heavier soils. The advantages claimed for ridge culture are better surface evaporation for heavy soils subject to excess moisture, easier weed control by covering, protection of tubers from late

blight spores, and easier digging. A hiller, the implement generally used for ridging, is shown in operation in figure 92.

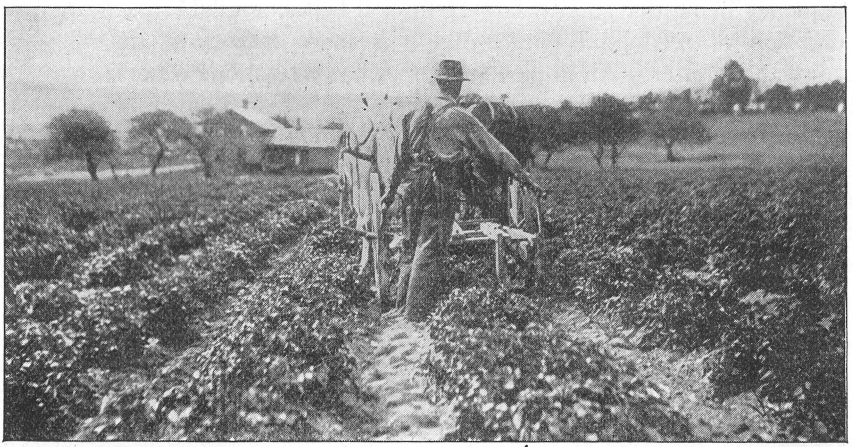

FIG. 91. CULTIVATION IS AN IMPORTANT FACTOR IN PRODUCTION

Where soil moisture is deficient and the soil of heavy type, cultivation every week or ten days is advisable to maintain a surface mulch for moisture conservation. Under moderate rainfall and on light soils less frequent tillage is necessary

Late-season cultivation should not be deeper than from two to three inches in order not to disturb the feeding roots, which develop close to the surface at this time.

FIG. 92. A POTATO HILLER IN OPERATION IN SOUTHERN NEW YORK

DISEASES AND SPRAYING

Potatoes are subject to numerous fungous, bacterial, and physiological diseases, many of which are prevalent in New York State. These may be

classified under three headings, according to the parts of the plant affected, as (1) those affecting the foliage only, (2) those affecting the tubers chiefly, and (3) those affecting both foliage and tubers. The most important of these are listed here:

1. Affecting foliage only
   - Early blight
   - Tipburn
2. Affecting tubers chiefly
   - Common scab
   - Powdery scab
   - Wart disease
   - Silver scurf
   - Internal brown spot
3. Affecting both foliage and tubers
   - Late blight
   - Rhizoctonia disease
   - Blackleg
   - Fusarium wilt
   - Verticillium wilt
   - Bacterial soft rots
   - Curly dwarf
   - Leaf roll
   - Mosaic

Detailed knowledge of the symptoms and the control measures for these diseases is not to be assumed on the part of the average grower. For this the experiment stations or the Department of Plant Pathology of the College of Agriculture should be consulted. However, the following general discussion indicates the relative importance of and control measures for some of these diseases.

Late blight is by far the most severe of all potato diseases. The general epidemic of 1915 is evidence of this fact. Its spread is favored by warm muggy days and an abundance of moisture. The causal organism hibernates within the seed and cannot therefore be controlled except by thoro spraying with bordeaux mixture. Seed free from blight is desirable but may not be necessary in the control of this disease. Spraying should always be done before rains rather than after, and should be frequent enough thruout the growing season to insure complete covering of all foliage. Newly developed foliage requires that the vines be sprayed at least every ten days to two weeks. Spraying late in the season is desirable even if vines completely cover the space between rows. The effect of frequency of spraying with bordeaux mixture on yield on 109 farms in Suffolk County in 1912 is given in table 7.

TABLE 7. RELATION OF SPRAYING WITH BORDEAUX MIXTURE TO YIELD ON 109 SUFFOLK COUNTY FARMS IN 1912

Times sprayed	Number of farms	Average yield per acre (bushels)
Less than 3	7	185.9
3 to 6	43	188.3
6 to 8	42	193.9
8 and over	17	221.6

Bordeaux mixture is usually made at a strength of 5 pounds of blue vitriol (copper sulfate) to 5 pounds of stone lime in 50 gallons of water. Some authorities state that weaker solutions, such as 3-3-50 or 4-4-50, may be used during the early part of the growing season. The mixture owes its fungicidal value to the poisonous effect of the blue vitriol. The lime neutralizes the vitriol to prevent burning of the foliage and makes the mixture adhesive. Stock solutions of lime and copper sulfate should be prepared before the time of spraying. The stock solution of lime is made by slaking a bushel of good stone lime or lump lime in a barrel, using at first only enough water to cause the lumps to crumble into fine pieces. Later more water may be added to make a paste, and finally enough water to make fifty gallons of milk of lime. This constitutes a stock solution of one pound of lime to each gallon of water. Hydrated, or slaked, lime may be used instead of stone lime, but ground limestone or air-slaked lime should never be used.

In a similar way a stock solution of copper sulfate is prepared, except that the fifty pounds of sulfate is suspended in the top of the barrel of water. As the crystals dissolve, the substance readily mixes with the water until a stock solution of one pound of copper sulfate to each gallon of water is formed.

In making the mixture, slightly more lime than vitriol should be used to insure that the mixture may not burn the foliage. The use of a few drops of yellow prussiate of potash (potassium ferrocyanide) in a sample of the mixture will test this point. A reddish brown reaction indicates an excess of vitriol and the need of more lime. The stock solutions should be added to the water separately, as mixing them previously results in a precipitate, which will clog the nozzles. Thoro agitation of the mixture and high pressure are essentials to successful spraying with bordeaux. Early blight is effectively controlled by this same means. A high-power traction sprayer that will treat seven rows at a time is illustrated in figure 93.

The insecticides used advisedly in combination with bordeaux mixture for the control of the Colorado potato beetle and the flea beetle are paris green and arsenate of lead. Paris green is used at a strength of 1 pound to 50 gallons of water, arsenate of lead at a strength of 4 pounds to 50 gallons of water. The organisms causing common scab and rhizoctonia disease, both of which require chemical seed treatment as previously discussed under *Seed*, also live over in the soil; therefore crop rotation is required to insure clean soil, as a further means of control. The organisms causing such diseases as the wilts, silver scurf, internal brown spot, blackleg, curly dwarf, leaf roll, and mosaic, which are carried over from one season

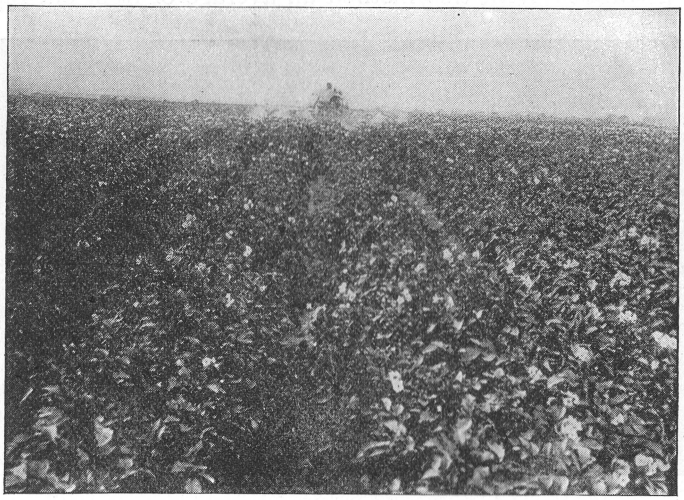

FIG. 93. A SEVEN-ROW TRACTION SPRAYER IN USE ON A LONG ISLAND POTATO FIELD

to another with the seed, require the selection of disease-free seed for their effective control. Blackleg is also partially controlled by chemical treatment. A wise precaution to take in order to prevent such diseases as the wilts, blackleg, mosaic, curly dwarf, and leaf roll, and plants showing weak or spindling sprouts, is to select seed tubers from healthy plants during the growing season.

HARVESTING

Harvesting for many sections of the State is done at a time convenient to other farm operations. This is due to the common idea that potatoes are not damaged by being left in the soil after maturity. This is true in so far as weather is favorable and the danger of rot and early freezes

not serious. The late crop is usually not dug until the tops are dead, whereas the early crop is in many cases harvested as soon as the tubers are of marketable size. This makes it possible to take advantage of early market prices, and in the trucking sections to follow the crop by some short-season vegetable crop, such as turnips or late cabbage. Potatoes should not be dug from a field badly infected with late blight until all tops are dead, as digging before this would tend to spread the infection from diseased vines to the tubers. For the same reason, potatoes should never be covered in the field with blighted tops to prevent sunburning.

The old method of digging with a spading fork or hook is common on small acreages. With this method an average of from one-fourth to

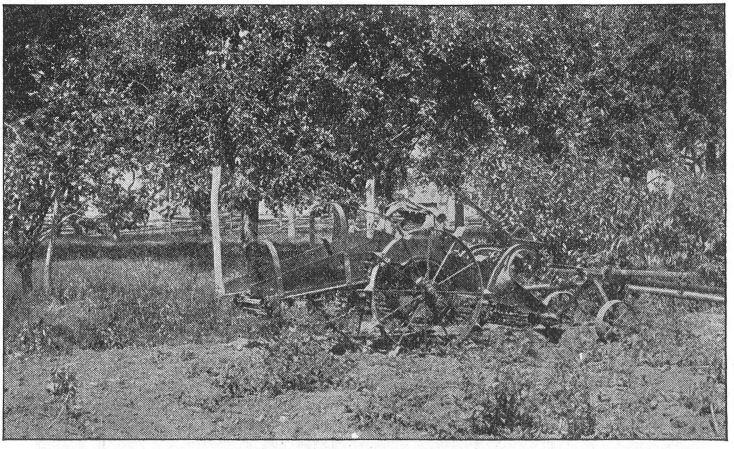

FIG. 94. A MODERN CHAIN ELEVATOR POTATO DIGGER

three-fourths of an acre can be dug in a day, depending on the type of soil, the yield, and the man digging. Sometimes the crop is plowed out with either a common or a shovel plow. The objection to this is the large amount of tubers covered or never brought to view. It may be advisable on small areas, however, where the soil is heavy and labor for digging expensive. Modern machine diggers of the chain elevator type, costing from $80 to $125, are now in general use on most of the large potato farms. These often require extra horses for operation, but an average of five acres can be conveniently dug with them in a day. This type of modern digger is shown in figure 94.

In order to lessen danger from inclement weather, freezing, and sunburning, potatoes are usually picked up immediately after being dug. Square slatted crates of one bushel capacity are most common except in the trucking section of Nassau County, where large splint baskets

are used in hauling directly to market. Such crates are convenient to handle and are desirable for cellar storage since they permit thoro ventilation, when piled in large bulk, and easy removal from storage at planting time.

STORAGE, MARKETING, AND GRADING

During the normal storage season and under average storage temperatures of 45° to 55° F., potatoes shrink from six to eight per cent from water loss alone. This is a factor to be considered in determining the advisability of storage at all. Long Island growers market practically the entire crop at harvest time, while growers in other sections of the State market a part and store the rest partly in accordance with their storage facilities. As a rule potatoes are stored at too high temperatures. Experiments conducted at the New York (Geneva) Agricultural Experiment Station[1] show that in case storage temperatures are likely to remain at 50° F. or higher it is unsafe to pile potatoes in bulk higher than three feet. Also it was shown that it is never safe to pile potatoes higher than six feet, irrespective of temperature. Too much bulk results in insufficient oxygen for normal respiration and the consequent discoloration of flesh, known as blackheart.

A study of potato prices averaged over a series of years indicates the advisability of marketing at harvest time. This takes into account the extra labor of handling, the risk of loss by disease, shrinkage, or freezing, interest on the average value of the stored crop, and the rental of storage. By studying crop reports for information on the probable production for a current year, and assuming the average per capita consumption to be about 3.5 bushels, one can estimate the likelihood of overproduction or crop shortage.

Grading potatoes in New York has had little impetus until recently, and very few have been put on the market as graded stock. It is highly probable that more income could be realized from the crop if only standard tubers graded over a $1\frac{7}{8}$-inch screen were put on the market and the remainder fed at home. The United States Department of Agriculture now recommends that potatoes graded over a $1\frac{7}{8}$-inch screen for round varieties, and a $1\frac{3}{4}$-inch screen for long varieties, shall be known as U. S. Grade 1, and potatoes graded over a $1\frac{1}{2}$-inch screen shall be known as U. S. Grade 2. Practical freedom from disease and blemishes are also considered in the qualification for these grades. This would provide for the discarding of a large amount of diseased and mechanically injured tubers, which now find their way to most markets, and would result in a more uniform product.

[1] Blackheart and the aeration of potatoes in storage. F. C. Stewart and A. J. Mix. New York (Geneva) Agricultural Experiment Station. Bulletin 436.

VARIETIES

There is probably no one best variety of potatoes, tho in the immense number grown in this State there are some good ones and many poor ones. The variety to be chosen for a given locality should be one selected after inquiry into the prevailing group grown in that region. In many counties far too many varieties and types are grown. The growers who are concentrating on only a few varieties are the ones who are establishing a reputation. Examples of this are seen in Franklin and Clinton Counties and Suffolk County, Long Island.

Potatoes have been classified[2] into eleven groups, or families, as based mainly on color of sprouts, color of blossoms, shape, size, depth and frequency of eyes, and texture of skin. These groups are (1) Cobbler, (2) Triumph, (3) Early Michigan, (4) Rose, (5) Early Ohio, (6) Hebron, (7) Burbank, (8) Green Mountain, (9) Rural, (10) Pearl, and (11) Peachblow. Probably seventy-five per cent of the varieties grown in New York are of either the Green Mountain or the Rural group. It is generally impossible to distinguish definitely between varieties within the same group, but growers should as far as possible be able to identify one group from another. This would prevent a large amount of the present mixture of varieties. For example, varieties of the Green Mountain family generally are somewhat oblong-flattened in shape, and have a medium number and depth of eyes, somewhat netted skin, and no color in the sprout or blossom. Those of the Rural family are oval-flattened in shape, and have few and shallow eyes with long eye ridges, smooth skin, and sprouts with deep purple or blue tips, leaf scales, and bases. The Rural group of varieties has varying degrees of purple and blue in the basin of the flower, a characteristic not found in any of the other groups. This type exhibits a rather sparsely foliated and sprawling habit of top in contrast to the more upright and bushy top of the Green Mountain group. With these differences in mind, the grower of a variety of either of these two types should be able to detect and remove any mixture of the other type from his potato field. The safest criterion in discerning mixture is color in the blossom. All plants showing any color in the blossom corolla should be removed from fields of the Green Mountain type at blossom time. Likewise all plants not showing color in the corolla should be removed from fields of the Rural type at blossom time. Standard varieties of the Green Mountain family are Green Mountain, State of Maine, Gold Coin, Norcross, White Lady, Mills Prize, Carman No. 1, and Lincoln. Standard varieties of the Rural family include Rural New Yorker No. 2, Carman No. 3, Sir Walter Raleigh, Heavyweight,

[2] Group classification and varietal description of some American potatoes. United States Department of Agriculture. Bulletin 176.

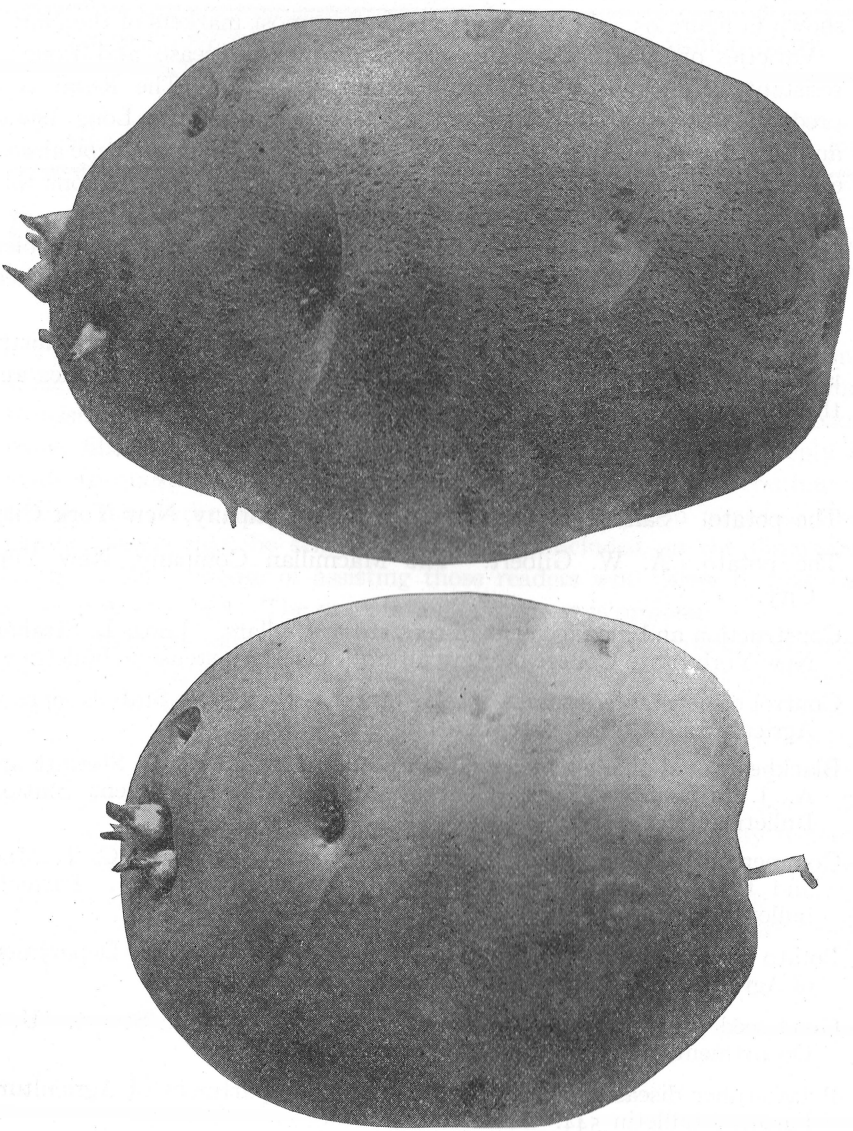

FIG. 95. STANDARD LATE-CROP VARIETIES OF POTATOES FOR NEW YORK STATE
Green Mountain above, Rural New Yorker No. 2 below

No. 9, Knoxall, and Dibbles Russett. Any of the varieties mentioned are desirable for the late crop. The type for each of these groups is shown in figure 95. Both command favor on most markets of the North.

Varieties of the Rural group are somewhat more disease- and drought-resistant than those of the Green Mountain group. The Rural type predominates in western and southern New York, while Long Island and Franklin and Clinton Counties grow the Green Mountain type almost exclusively. Experience has proved to the growers in these regions that these are the types best adapted to their conditions.

Standard early varieties for New York State are (1) Irish Cobbler, (2) Early Rose, (3) Early Ohio, (4) Bliss Triumph, (5) Early Manistee, and (6) Quick Lunch, ranking in about the order named.

One of the most important steps toward bettering the potato industry is the discarding of many of the existing so-called named varieties and the standardization of a few worthy sorts.

ADVANCED READING

The potato. Samuel Fraser. Orange Judd Company, New York City.

The potato. A. W. Gilbert. The Macmillan Company, New York City.

Construction and management of root storage cellars. James L. Strahan. New York State College of Agriculture. Cornell extension bulletin 22.

Control of vegetable diseases. I. C. Jagger. New York State College of Agriculture. Cornell extension bulletin 19.

Blackheart and the aeration of potatoes in storage. F. C. Stewart and A. J. Mix. New York (Geneva) Agricultural Experiment Station. Bulletin 436.

Commercial handling, grading, and marketing of potatoes. C. T. More and C. R. Dorland. U. S. Department of Agriculture. Farmers' bulletin 753.

Potato storage and storage houses. William Stuart. U. S. Department of Agriculture. Farmers' bulletin 847.

Good seed potatoes and how to produce them. William Stuart. U. S. Department of Agriculture. Farmers' bulletin 533.

Potato-tuber diseases. W. A. Orton. U. S. Department of Agriculture. Farmers' bulletin 544.

Potato wilt, leaf-roll, and related diseases. W. A. Orton. U. S. Department of Agriculture. Bulletin 64.

Potato breeding and selection. William Stuart. U. S. Department of Agriculture. Bulletin 195.

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LESSON 143 FARM CROPS SERIES MARCH, 1919

POTATO GROWING IN NEW YORK

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(*Detach, sign, and return for the next lesson in this series.*)

(In answering questions, attach additional paper if needed and number the answers.)

1. Where are potatoes best grown in the rotation? Why?

2. In what ways may the fertility of the soil be increased for the benefit of the potato crop?

3. What factors make the occasional renewal of potato seed advisable?

4. Which potato diseases may be effectively treated with formalin? Which with corrosive sublimate? What strength of each solution is recommended?

5. What is the relation of amount of seed, size of piece, and number of eyes to yield? How many bushels to the acre is it generally profitable to plant?

6. What advantages are claimed for the checkrow and the drill-row system of planting potatoes?

7. Name the advantages claimed for ridge culture of potatoes. What factors determine the degree of ridging?

8. Define or describe the potato diseases which have given you the greatest trouble. What have you done to control these?

9. Do you spray your potatoes with bordeaux mixture regularly? If so, with what success? If not, have you ever given this practice a fair trial?

10. Have you ever graded your potatoes over a mechanical sorter? If so, how much advance in price over unsorted stock did you get?

11. Name the various early and late varieties of potatoes grown in your locality. Which of these seem to yield best? What advantages would you expect if only five or six standard varieties were grown in your neighborhood?

12. Discuss what you consider to be the most important potato problem confronting your locality?

Name.....

Address .....

Date.....

(*Address all correspondence to the Reading Course for the Farm, College of Agriculture, Ithaca, New York.*)